

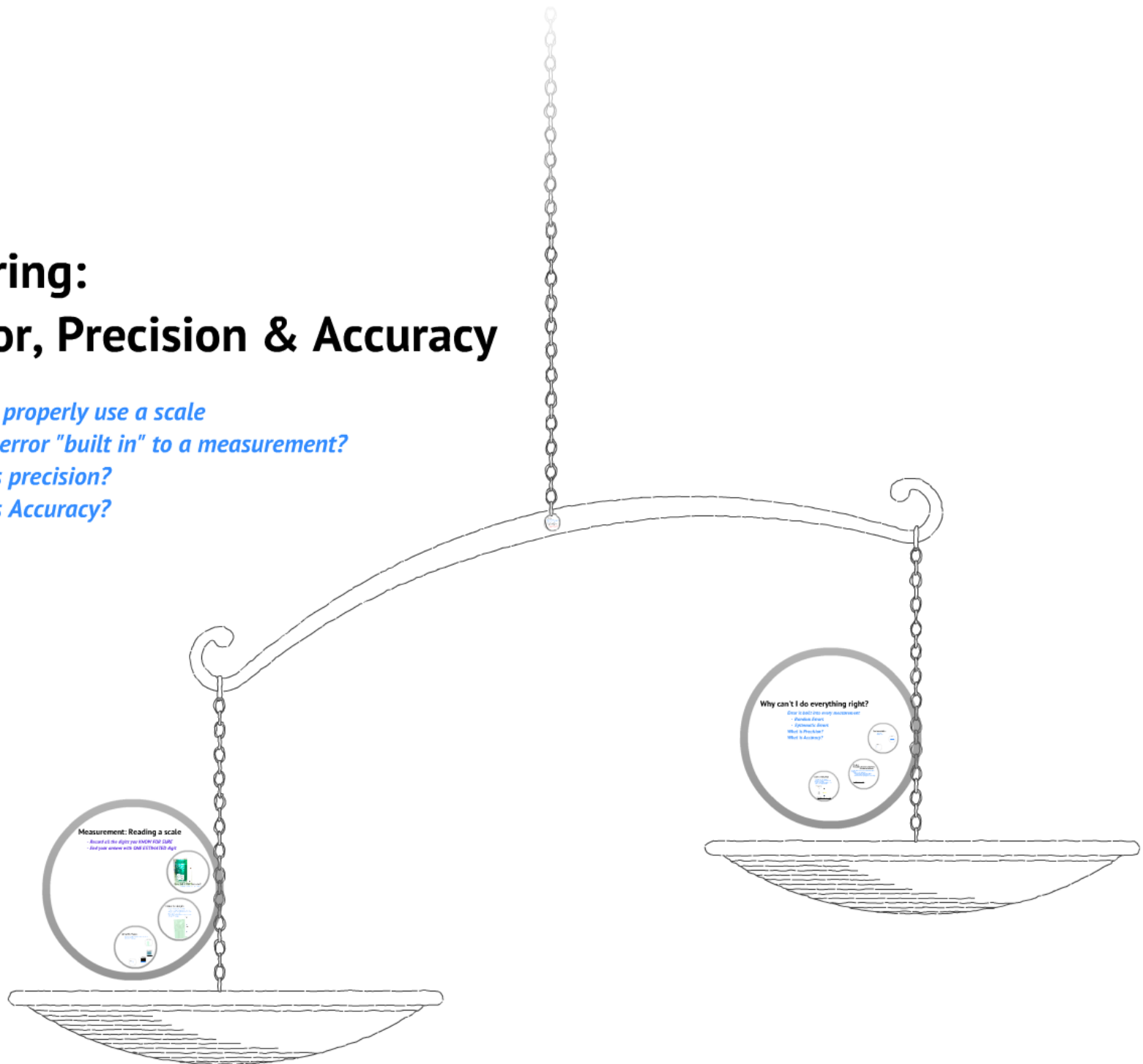
Measuring: Error, Precision & Accuracy

How to properly use a scale

Why is error "built in" to a measurement?

What is precision?

What is Accuracy?



Measuring:

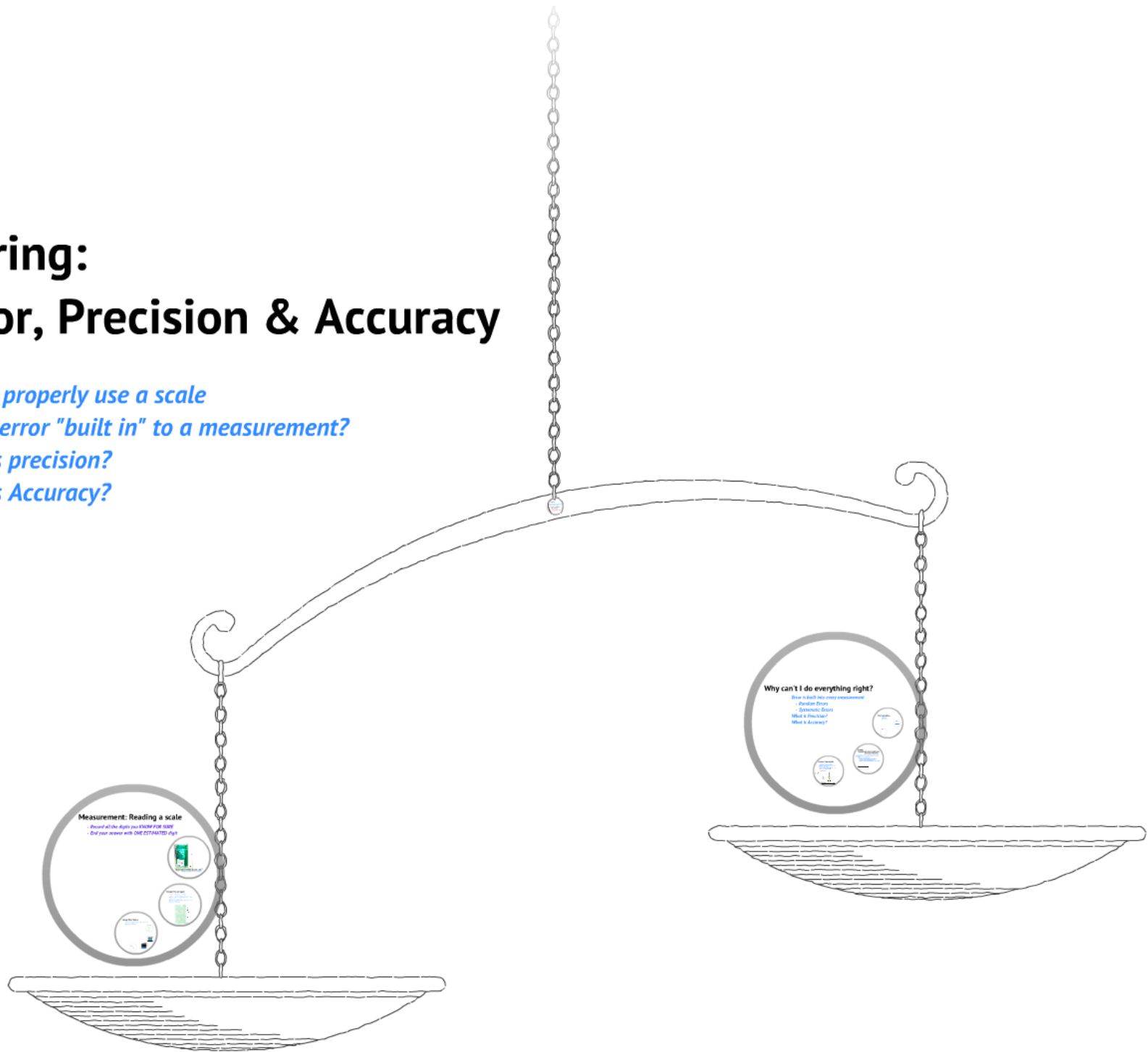
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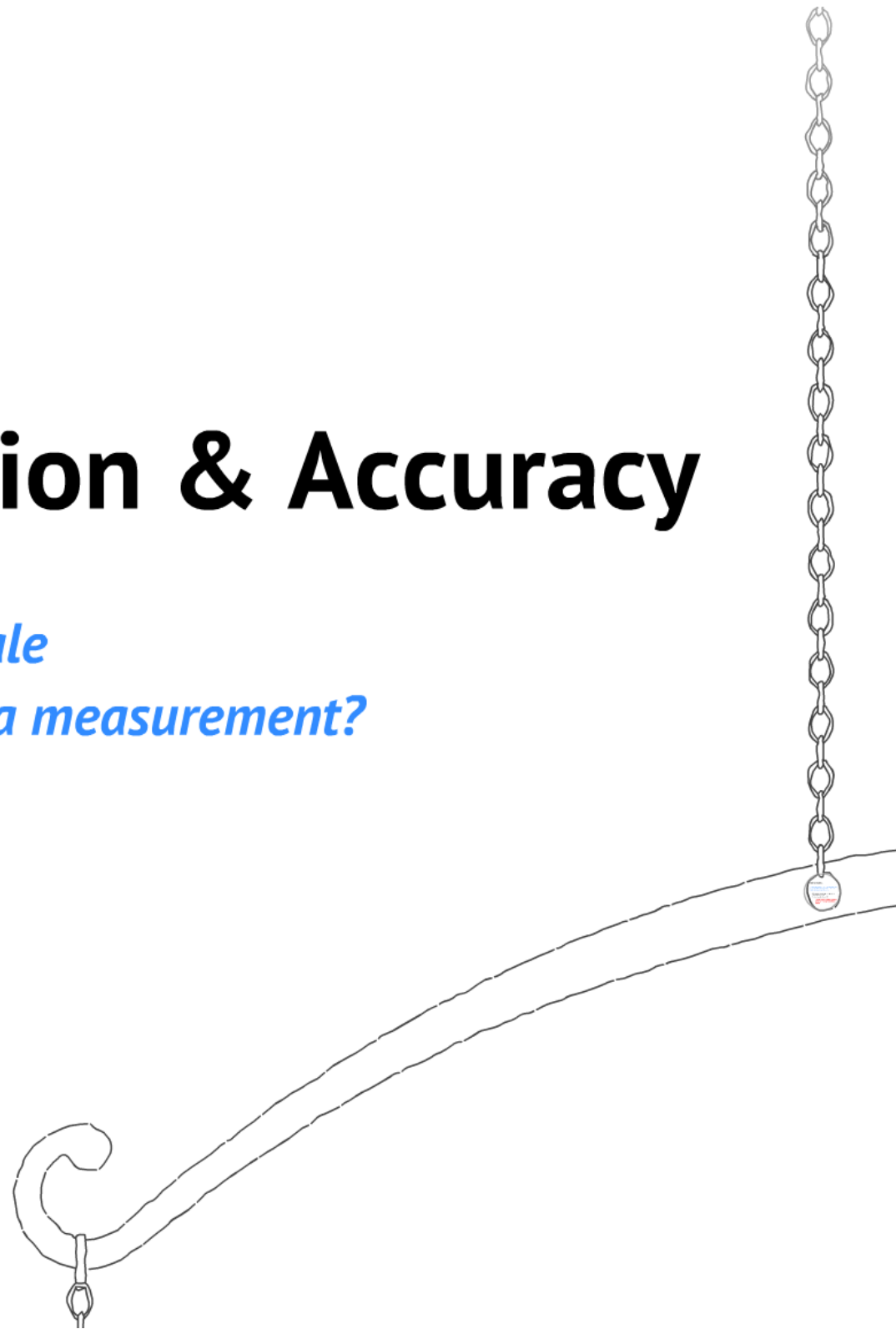
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Measurement: Reading a scale

- Record all the digits you **KNOW FOR SURE**
- End your answer with **ONE ESTIMATED** digit



How tall is this soda can?
Give your measurement in centimeters

Measure the can again

- The tick marks help to improve your measurement by giving you a better reference.
- You still need to make a guess, but this time your guess is better informed.
- Report all the digits that you know for sure, and **ONE ESTIMATED** digit.



Using Other Scales

- Report all the digits that you know for sure, and **ONE ESTIMATED** digit.





How tall is this soda can?

Give your measurement in centimeters

Measure the can again

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ONE ESTIMATED digit.



Using Other Scales

- *Report all the digits that you know for sure, and ONE ESTIMATED digit.*

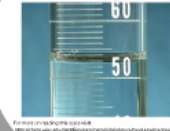
A. The Can: One Last Time

What is the height of the can according to this scale?



B: The liquid in a Graduated cylinder

Be sure to read from the bottom of the "meniscus"



C: How Many RPM Does the Tachometer Read?



Answers:

- A. 8.73 cm
- B. 52.9 mL
- C. 690 rpm

A. The Can: One Last Time

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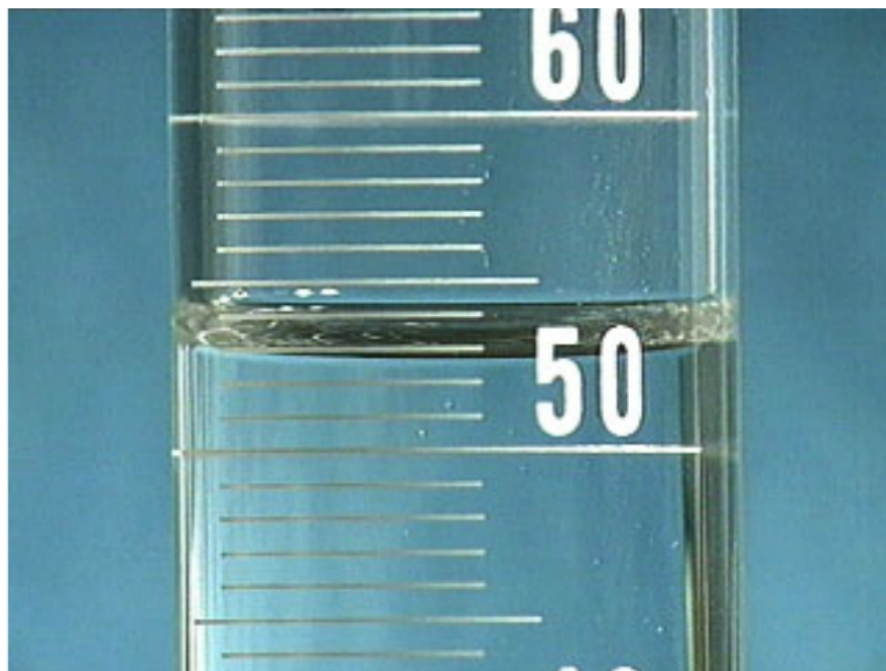
What is the height of the can according to the ruler?

What is the height of the can according to the ruler?



B: The liquid in a Graduated cylinder

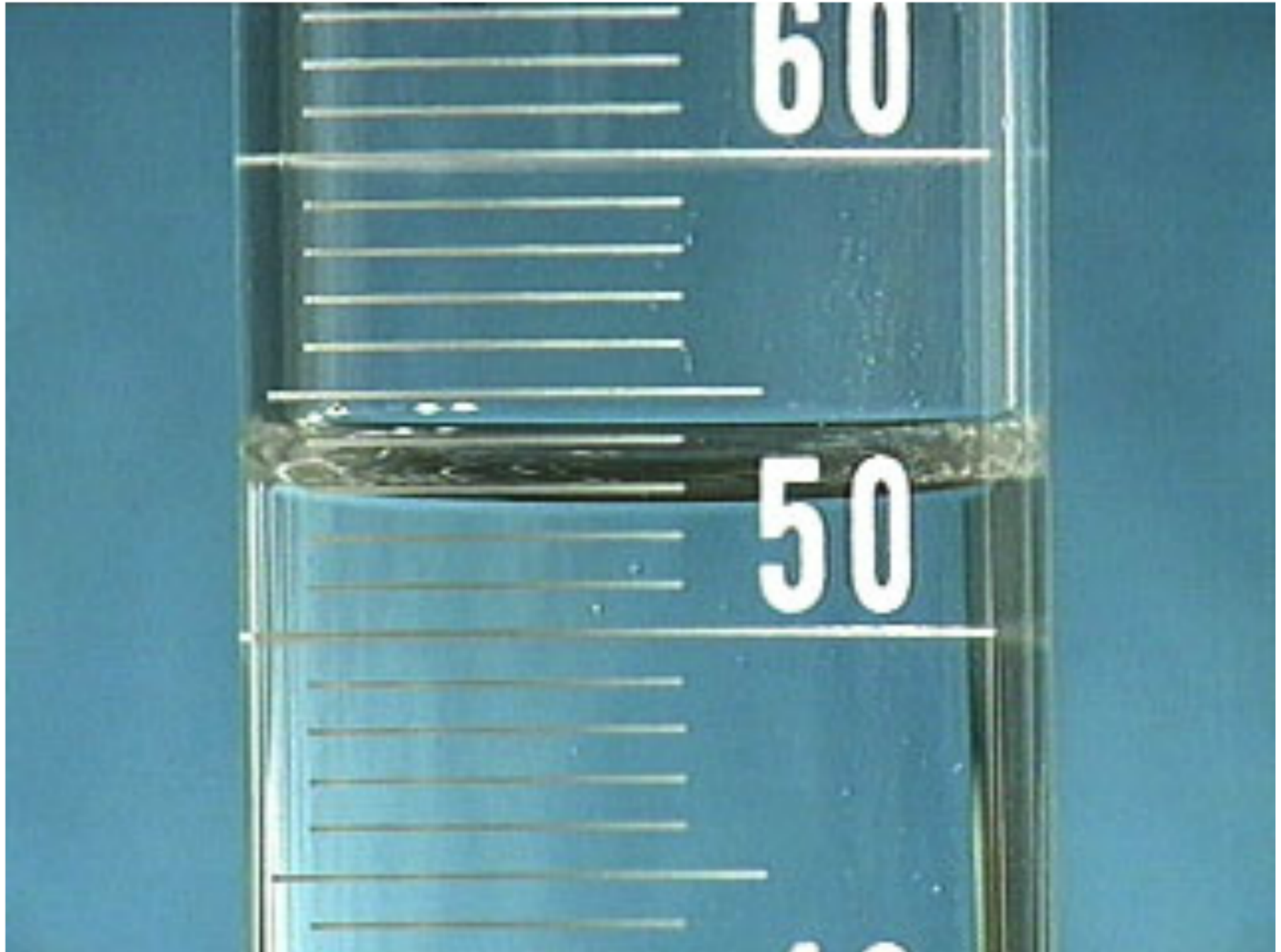
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For more on reading this scale visit:

<http://chem.wisc.edu/deptfiles/genchem/lab/labdocs/modules/gradcyl/grad100mL.htm>

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or more on reading this scale visit:

C: How Many RPM Does the Tachometer Read?



Image acquired from

<http://newcarstop.com/mitsubishi/review-2011-mitsubishi-outlander-sport-se-awc/>



x1000r/min

Answers:

A. 8.73 cm

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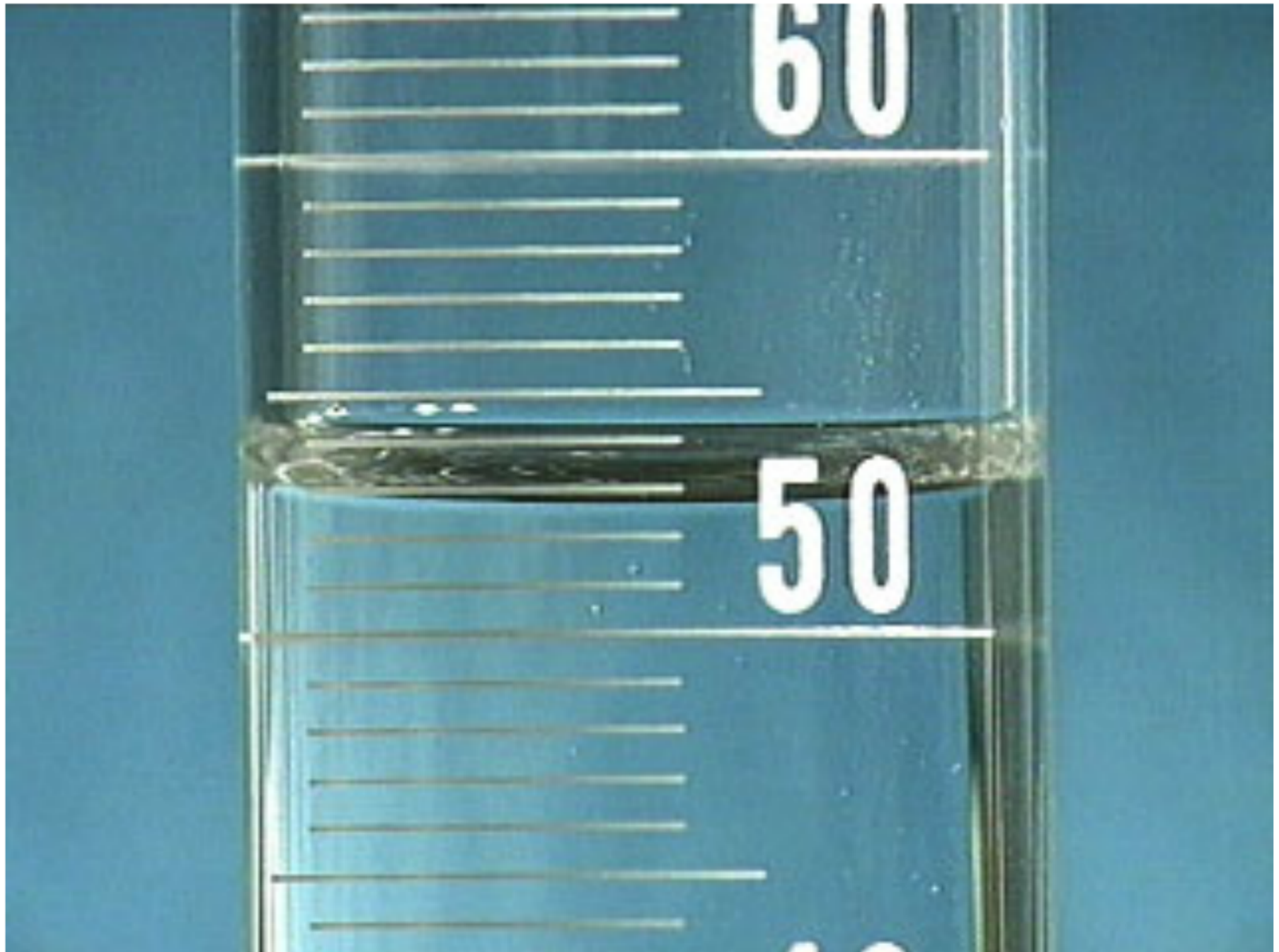
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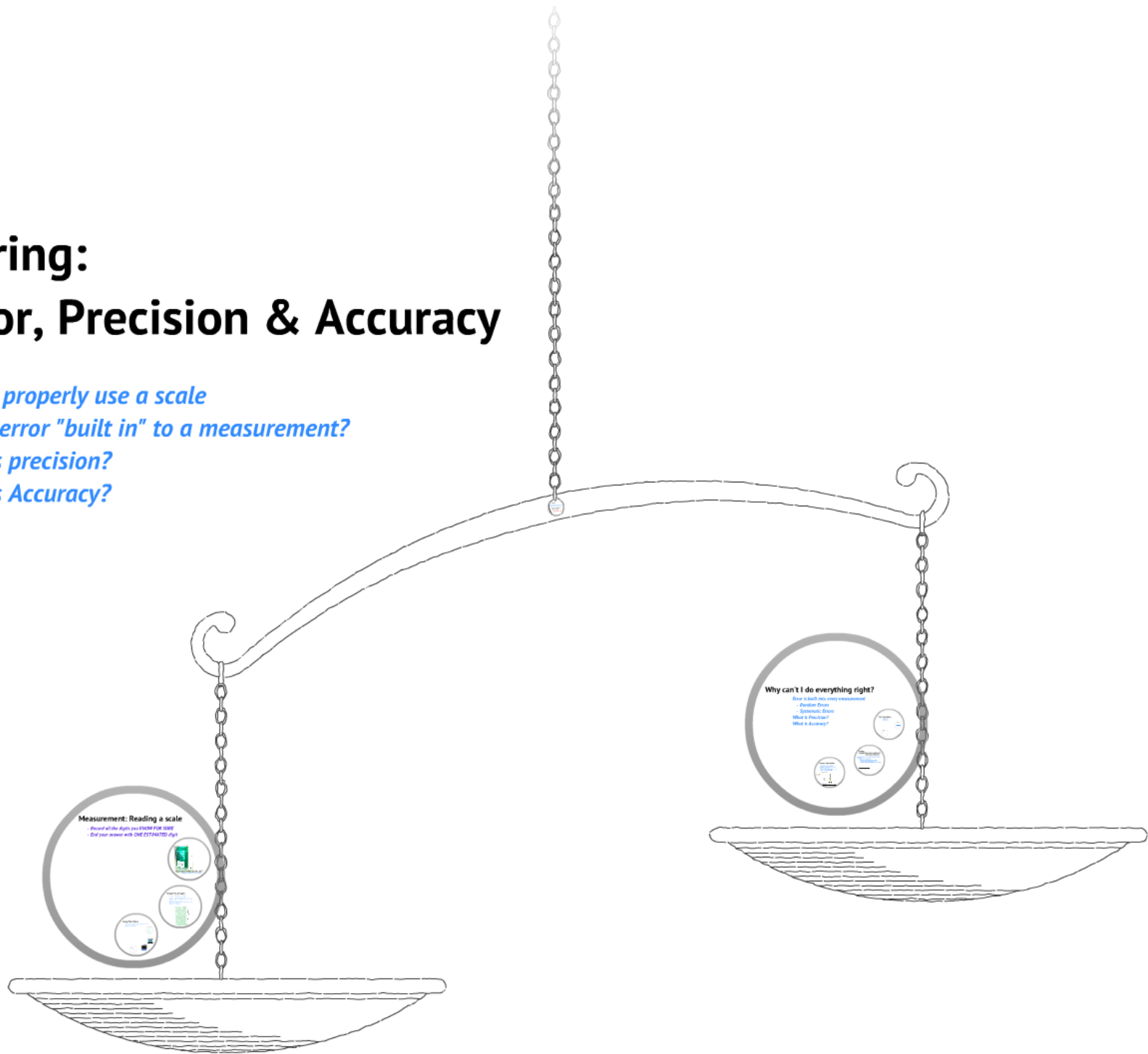
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Why can't I do everything right?

Error is built into every measurement

- Random Errors
- Systematic Errors

What is Precision?

What is Accuracy?

Error is unavoidable...

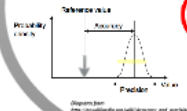
- Random Error
- Systematic Error

Precision:
Reproducing the same measurement
over and over and over...

Precision is a way to describe the reproducibility or repeatability of a measurement.
The target below shows high precision.
Precision can be improved by using better equipment.
Measurement repeated with and without a ruler.
Precision can be improved by taking your time when measuring.

Accuracy: Getting it right!

Accuracy describes how correct you are.
Someone has to know the correct answer before
you can speak of accuracy.
You can be accurate without being precise. That
means it is far from being truly though...



Why can't I do everything right?

Error is built into every measurement

- *Random Errors*
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What is Precision?

What is Accuracy?

Error is unavoidable...

- *Random Error*
- *Systematic Error*

Random Errors

- You cannot avoid them. Forget about ever getting "perfect" results. All you can hope for is reduced imperfection.
- "Random error is caused by unpredictable fluctuations in the readings of a measurement apparatus, or in the experimenter's interpretation of the instrumental reading; these fluctuations may be in part due to interference of the environment with the measurement process." - Wikipedia
 - (http://en.wikipedia.org/wiki/Random_error)
- You can try to minimize them by using good technique and precise equipment.
 - Ex of measuring the can...
- Taking a large number of readings and averaging them can help to greatly reduce the amount of random error.

Systematic Error

- This one is **YOUR FAULT...** or the machine's!
- Systematic errors are caused by faulty equipment, or faulty use of good equipment.
- Examples:
 - 1. You forget to zero a balance...
 - 2. You set your watch 5 minutes fast...
 - 3. You measure all of your patients with their shoes on...
- Systematic errors can be discovered by using your method to find a known value or by using a different method to take the same measurement.
- Systematic errors can be corrected if discovered.

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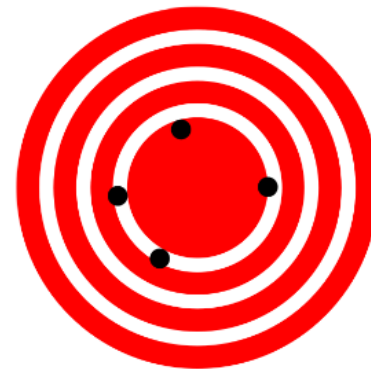
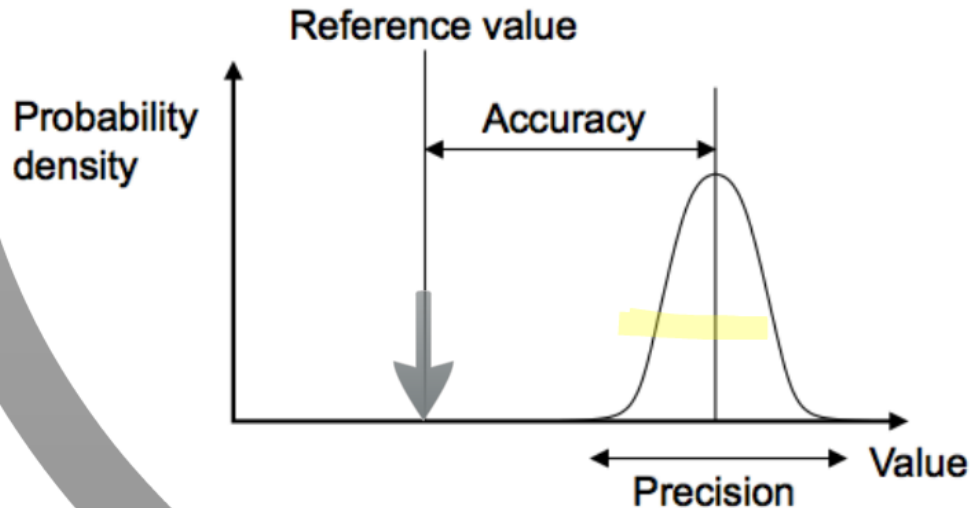
- *The target below shows high precision*
 - *Precision can be improved by using better equipment.*
 - *Measurement spread with and without a ruler*
 - *Precision can be improved by taking your time when measuring*

Diagram from
http://en.wikipedia.org/wiki/Accuracy_and_precision



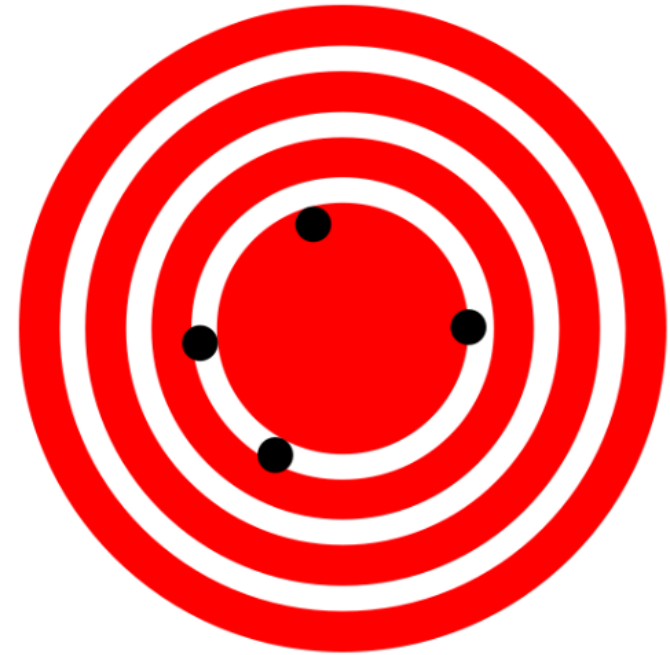
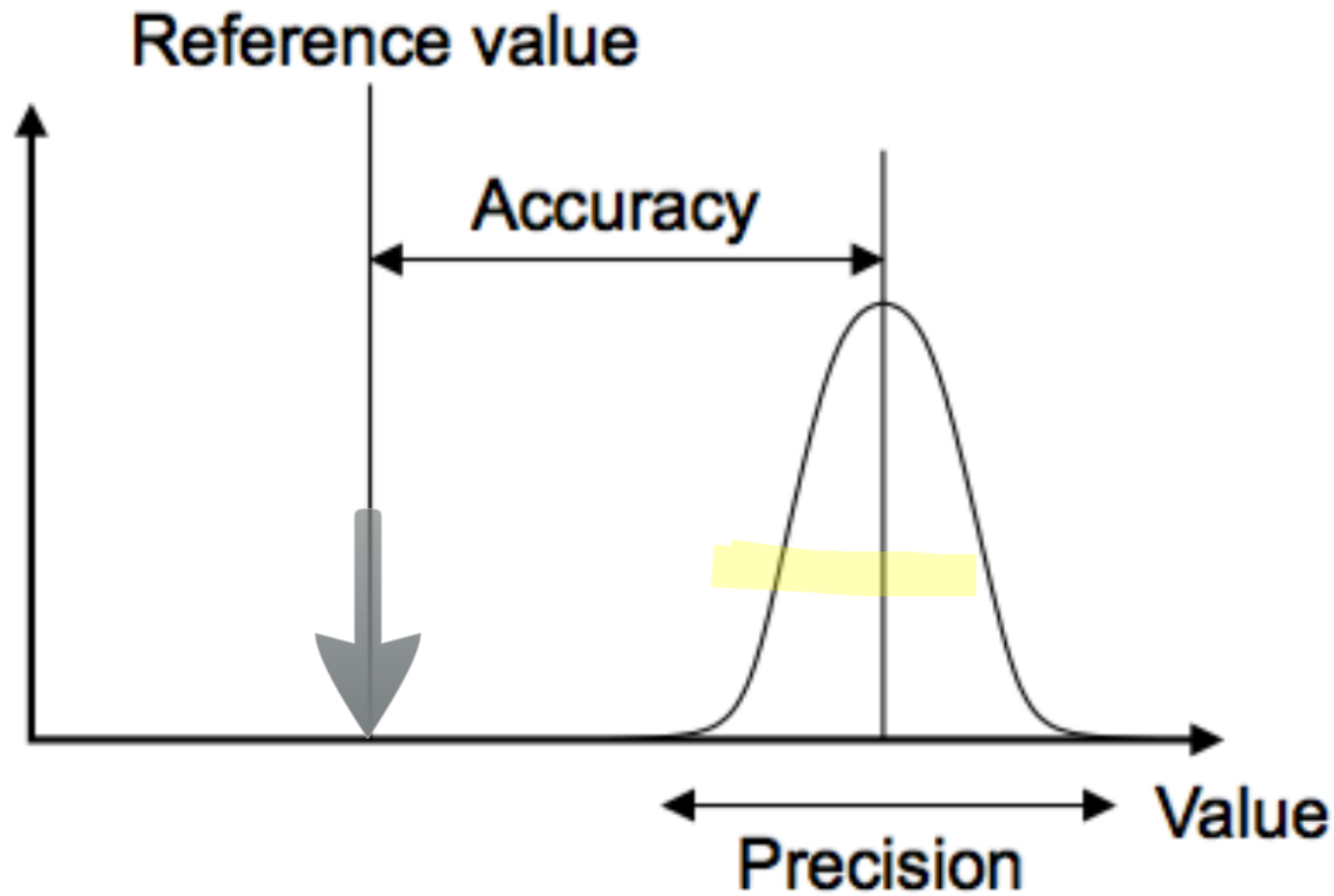
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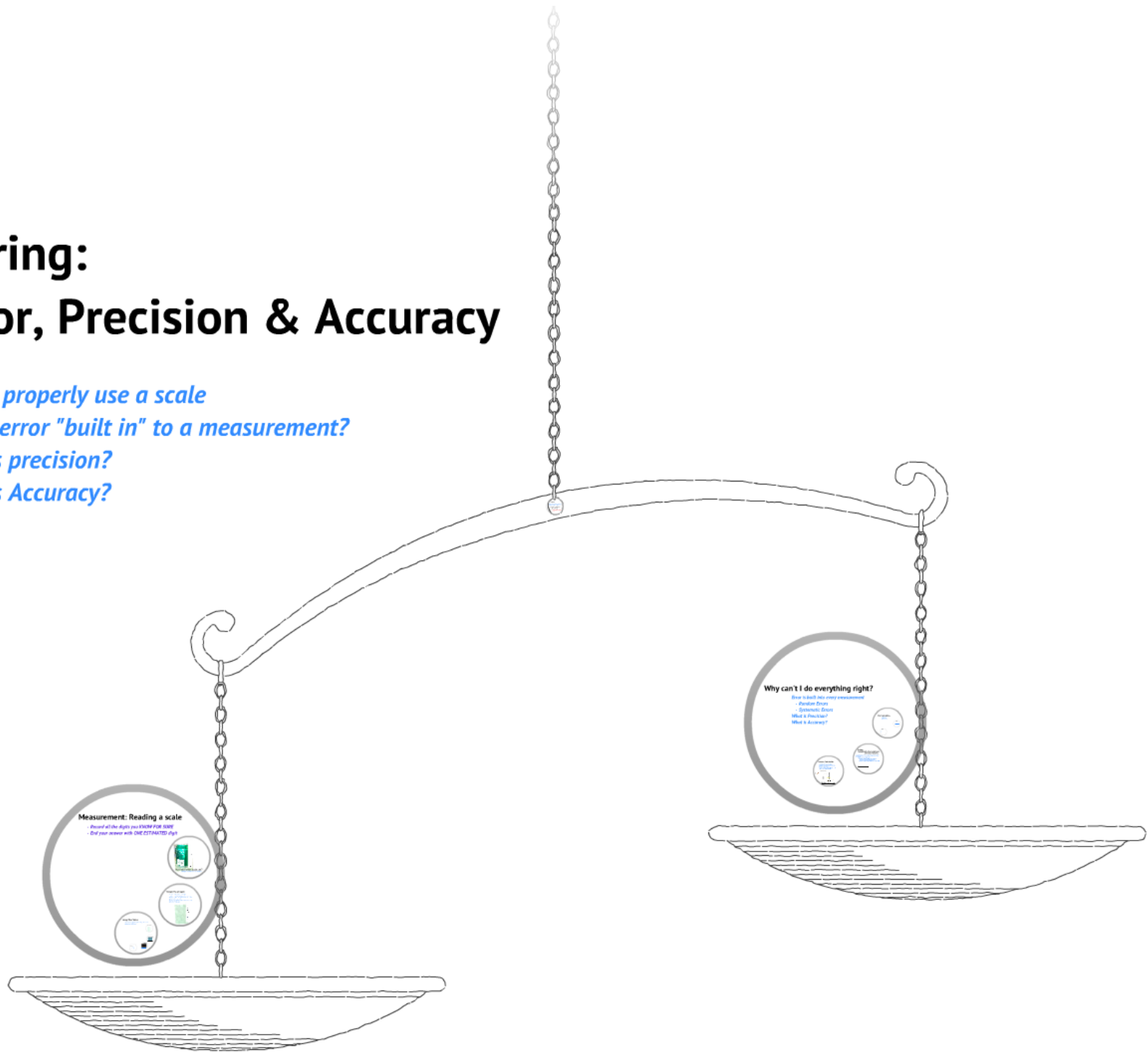
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Food for thought...

I showed you situations in which a target shooter was precise but not accurate, and another in which the shooter was accurate but not precise.

What would the target look like if you were...

- 1. accurate and precise?***
- 2. neither accurate nor precise?***

What kinds of error are you likely to encounter in both cases? Is one type of error likely to dominate?

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